Space Weather Technical Forecast

Issued on Sunday 1 December 2024 at 01:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-flares. Slight Chance of peak G1/Minor Geomagnetic Storm conditions Day 2 or 3 (02 or 03 Dec).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low during the past 24 hours, with a peak C9.3 flare observed at 30/0906 UTC from AR3906. There are currently eight sunspot regions. The largest and most complex of these are AR3905 (Eho/Beta) and AR3906 (Eki/Beta-Gamma) in the southwest. Both regions evolved slowly, with limited flare activity and some slight decay observed in their intermediate spots. The remaining regions on the disc are smaller and more magnetically simple, with no significant change in appearance during the period. AR3911 rotated over the western limb, meanwhile two new, small bipolar regions developed in the northeast and southeast disc.

No Earth-directed CMEs were observed during the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, measured by ACE at L1, has been Background to Slightly Elevated, ranging between 340-440km/s. Density has been largely Average to Below Average, but occasionally reached Above Average levels, both early and late in the UTC day on 30 Nov, peaking at 18ppcc at 30/2229 UTC. Total magnetic field strength (Bt) was generally Moderate, peaking at 11nT. The north-south component Bz, initially varied between negative (southward) and positive (northward) orientations, ranging between -8/+8nT, although has generally been steady and largely positive (northward) since 30/0400 UTC. Phi angle periodically varied between negative (towards the Sun) and positive (away from the Sun) sectors until around 30/1130 UTC, after which it has become predominately negative (towards the Sun). Geomagnetic activity was Active (Kp4) between 30/0000-0300UTC, after which activity has been Quiet (Kp0-2).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at mainly Background, with a brief peak at Moderate levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 01/0000 UTC was 1.18e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares, and a very slight chance of X-class flares.

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Solar Wind / Geomagnetic Activity: A slow CME seen leaving the Sun on 27 Nov is likely to give Earth a glancing impact on Day 2 (02 Dec) or early Day 3 (03 Dec), but with limited enhancements to solar wind parameters expected. This may combine with a weak high-speed stream from a small, equatorial coronal hole on the same days, but solar winds are expected to remain at, or close to Background levels throughout.

Overall, mainly Quiet Geomagnetic activity is expected with a chance of Unsettled intervals through the forecast period. There is a chance of Active (Kp4) conditions on Day 2 and 3 (02 and 03 Dec) with a very slight chance of G1/Minor Geomagnetic Storm intervals, should weak high-speed stream and CME influences sufficiently combine.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at background levels but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

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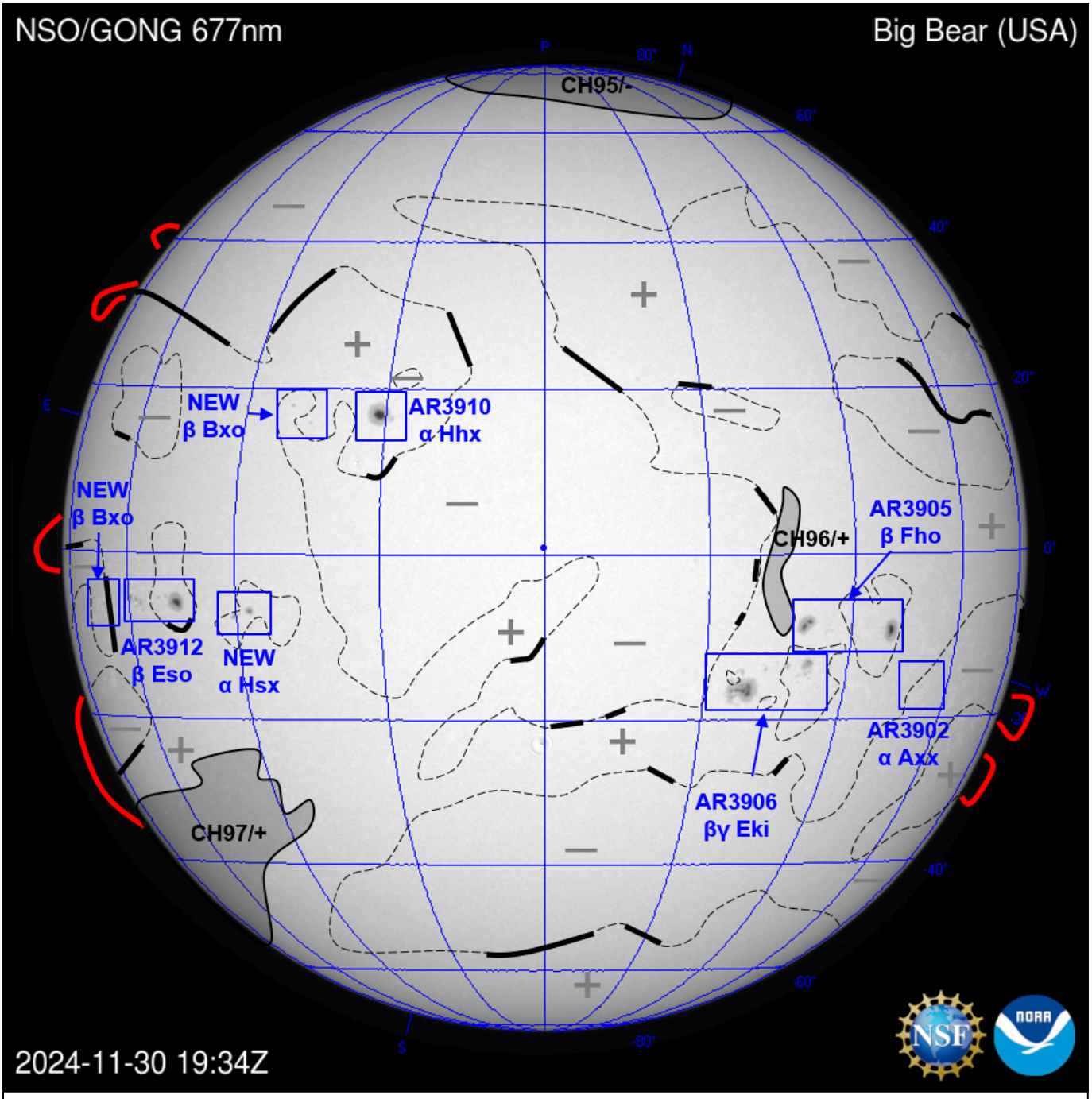
Figure 1: MOSWOC Solar Synoptic Map valid 30/1930 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A filament eruption from the southeast disc around 27/1900 UTC has been analysed to likely have a partial Earth-directed component. This feature is slow and is expected to pass largely below Earth's orbit, but should give a weak, glancing blow during Day 2 (02 Dec) or possibly early Day 3 (03 Dec). A number of other CMEs have been observed in recent days, however these are all expected to miss Earth with moderate-high confidence in their individual trajectories.

A high-speed stream associated with small, equatorial CH96/+, may give a weak enhancement to the solar wind between Days 2-3 (02-03 Dec). However, any enhancement is expected to be minimal, short-lived and could be masked by any glancing blow from the filament eruption CME that left the Sun on 27 Nov. No other significant enhancements to the solar wind are currently expected during the forecast period, with MOSWOC Enlil considered to be providing a reasonable steer for speeds between Days 1-3 (01-03 Dec) at mainly Background levels. A predicted increase to Slightly Elevated levels late on Day 4 (04 Dec), associated with a more substantial high-speed stream in the southern hemisphere, (likely CH97/+), appears to be too fast and too early with its onset based on its current position on the disc.

Overall, mainly Quiet Geomagnetic activity is expected with a chance of Unsettled intervals through the forecast period. There is a chance of Active (Kp4) conditions on Day 2 and 3 (02 and 03 Dec) with a very slight chance of G1/Minor Geomagnetic Storm intervals, should weak high-speed stream and CME influences sufficiently combine.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	20	10	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
28/11/2024 04:28	Partial	Filament	SE	390	02/12/2024 14:00 UTC	Moderate confidence of a glancing blow. Minimal enhancement expected.

Figure 2: Latest MOSWOC Enlil output valid 02/1400 UTC, estimated time of glancing CME arrival.

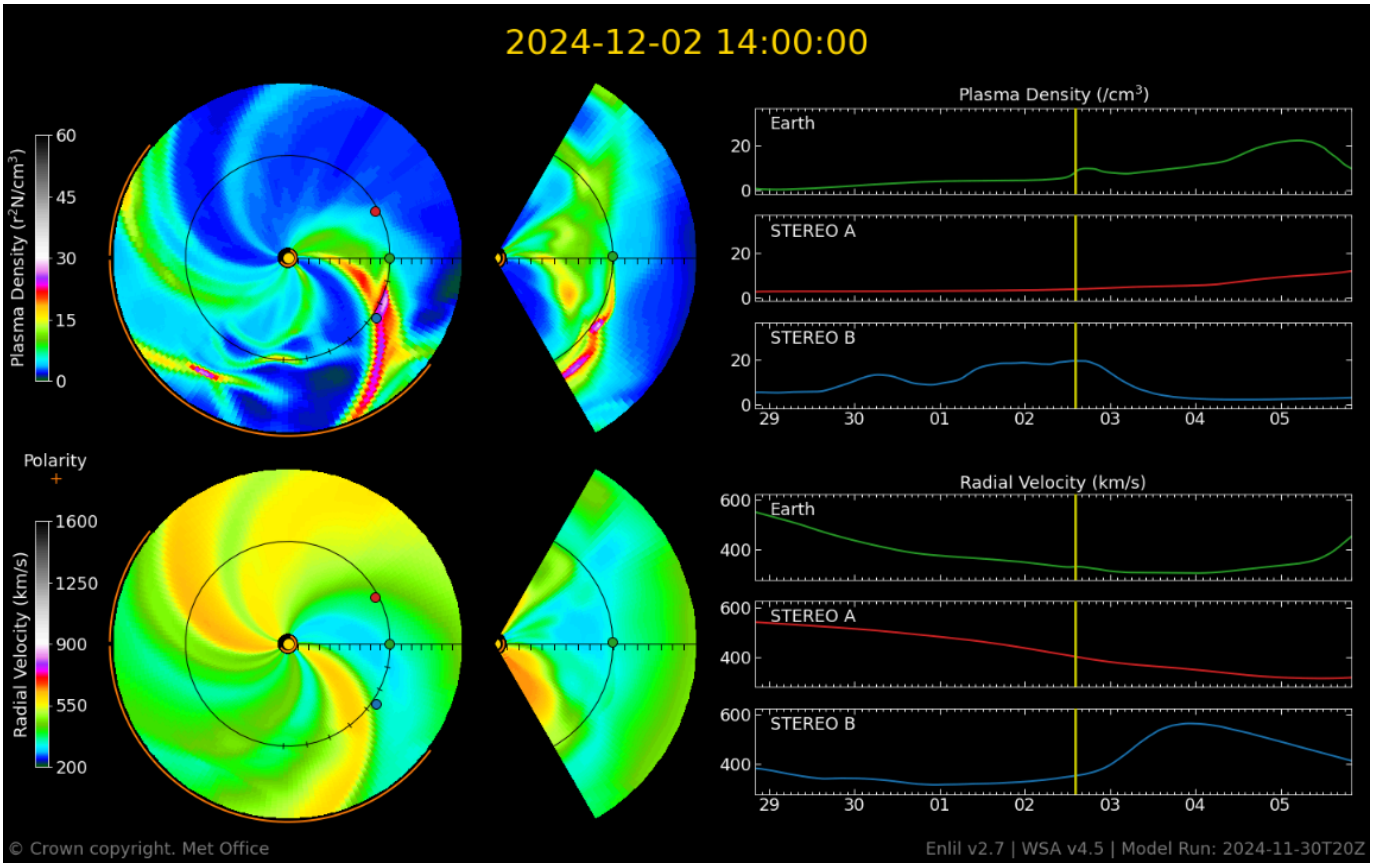

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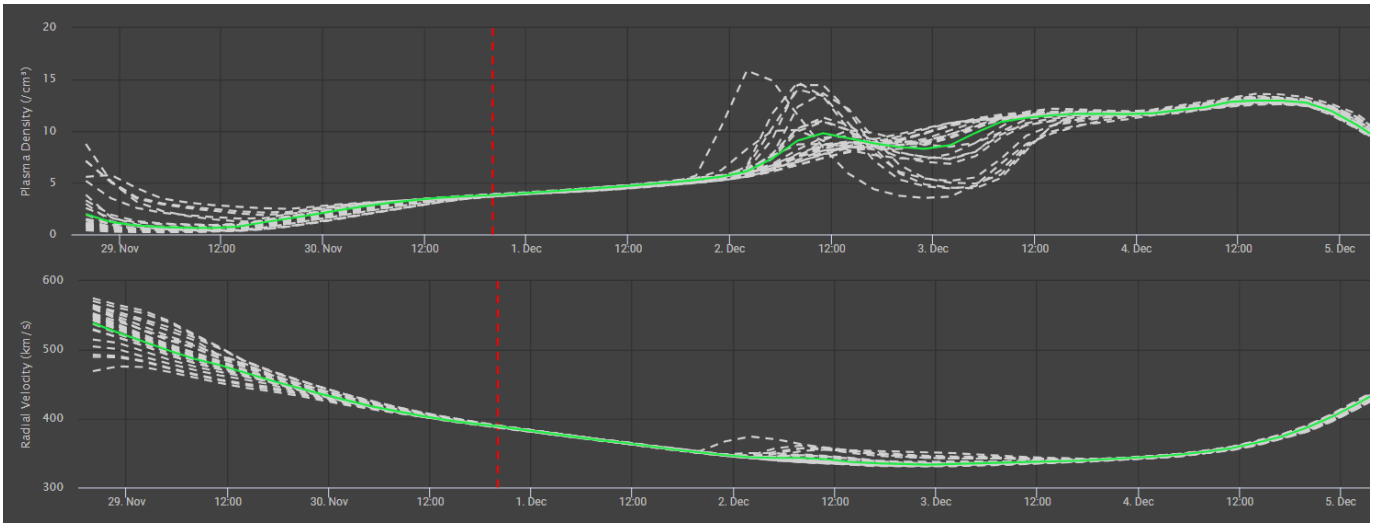
Figure 3: Latest MOSWOC Enlil Ensemble output. Indicating likely minor CME enhancement between 02-03 Dec.



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Radio Blackouts - X-Ray Flares

Solar Activity is Low with a peak C9.3 flare observed at 30/0906 UTC from AR3906.

There are currently sunspot eight regions on the visible disc, including three unnumbered regions. The largest and most complex regions are AR3906 and AR3905, both in the southwest. Some interaction is likely to occur between these two closely located regions. The former maintains a large, asymmetrical trail spot and a Beta-Gamma Mount Wilson classification, but is largely inactive at this time with limited change in appearance over the past 24-hours. AR3905 has a more 'open' appearance than AR3906 and also evolves slowly. The remaining regions on the disc are smaller and more magnetically simple, and included two new, small bipolar regions. One emerging to the east of AR3910 in the northeast, the other to the east of AR3912 in the southeast.

Assessment of sunspot regions is currently more challenging than usual as JSOC/Stanford was affected by significant flooding on 2024-11-26. SDO imagery from JSOC is expected to be unavailable until early 2025.

AR3905 will begin to rotate over the western limb on Day 4 (04 Dec), otherwise no current notable regions are expected to depart the visible disc during the period. Areas of bright flux and magnetic looping are evident on GOES-16 SUVI 94 and 171 imagery near the eastern limb, with persistence forecasting indicating several potential returning regions during the forecast period. Therefore it is possible that the probabilities of significant flares may increase over indicated levels in the coming days.

Low to Moderate activity is expected with a chance of isolated M-class flares, and a very slight chance of X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	45	45	45	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

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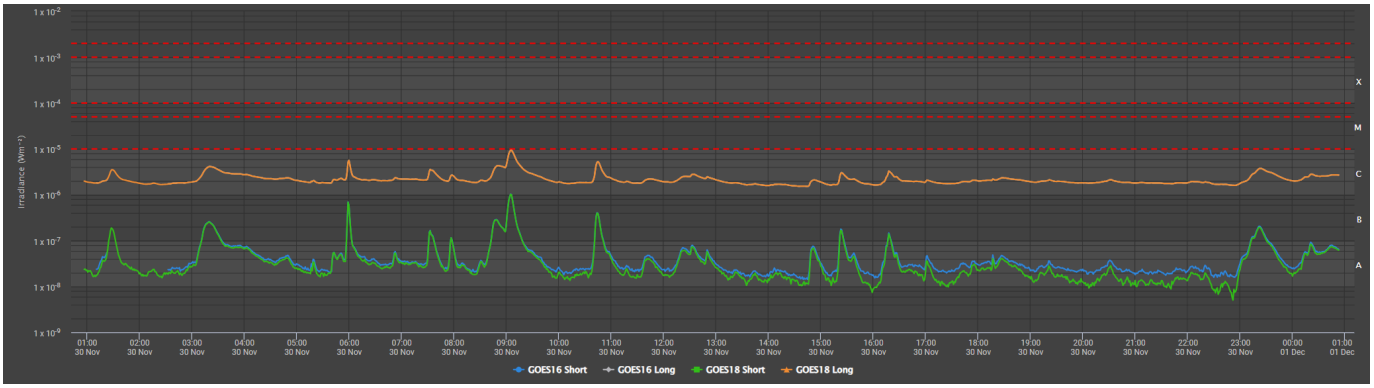
Figure 4: Latest GOES16/18 X-Ray Flux



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at background levels. As AR3905 and AR3906, the two most magnetically complex regions on the disc, continue to rotate across the western hemisphere, the chance of solar radiation storms will increase slightly during the period. However, these regions have not shown any notable flare activity in recent days resulting in only a slight chance of observable high energy protons being ejected.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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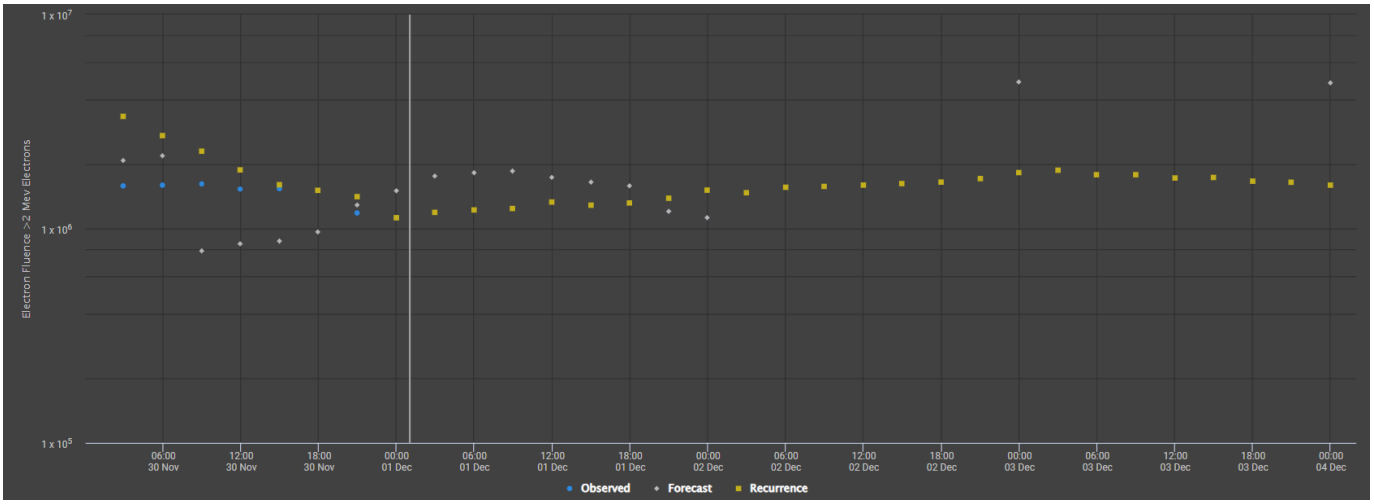
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at Background levels, with no significant coronal hole or CME enhancements currently anticipated during the forecast period. Therefore, Electron Flux is most likely to remain at mainly Background levels, with brief increases to Moderate flux possible at diurnal max.

The associated 24 hr fluence is expected to persist below Active levels, with MOSWOC REFM recurrence currently considered to be providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^8**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ 1×10^9**	No	1	1	1	1

Figure 5: Latest MOSWOC REFM >2MeV Electron Fluence forecast with Recurrence. Fluence expected to remain well below Active threshold.



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